for a short period and then returns to a normal figure even though the immune bodies are still present in the blood. The experiments further suggest that the hyperglycemia which follows the injection of substances generally supposed not to be capable of inducing antibody formation (*i. e.*, fats, polypeptids) may serve as a method for testing the reactions of the body when neither precipitins, agglutinins nor lysins are demonstrable. From a practical standpoint the absence of a hyperglycemia after the injection of a given substance known to induce hyperglycemia might be taken to indicate the point of maximum antibody production in the individual or animal in question.

OBSERVATIONS ON SOME TESTS OF PHYSICAL FITNESS.

By Paul D. White, M.D.,
MASSACHUSETTS GENERAL HOSPITAL, BOSTON, MASS.

Certain facts of considerable interest were obtained from tests carried out in France at U. S. Base Hospital No 6 during the summer of 1918.[1] At first plans for careful work were hopefully made, but the routine became soon so overwhelming that only the initial tests could be completed satisfactorily. Because of two or three important conclusions to be drawn from these tests and from the observations that followed I am making this report.

In June and July, 1918, I took over the care of the gassed cases, chiefly those convalescent, and continued this work until after the Armistice. The first task was to organize the wards, which shortly developed into a camp of several hundred patients. By October I was swamped by 500 cases in the clinic at one time, but the routine was developed satisfactorily.

The second task and the more important was to decide at what time the soldiers were fit to return to combat duty; or when they should be reviewed by the Disability Board for assignment to special duty under the classification B-1, B-2; C-1, C-2; or for return to the U. S. A. as of Class D.

A signified fitness for combat or active normal duty.
B-1 signified temporary non-combat normal duty.
B-2 signified temporary non-combat light duty.
C-1 signified permanent non-combat normal duty.
C-2 signified permanent non-combat light duty.

As time went on during the summer, work on the "gassed" cases became organized and convalescent patients from the other hospital wards were then sent to me to benefit by the exercises, games and

[1] I wish to express my appreciation for the great assistance rendered to me by Sergeant John O. Moose.

semi-military life. Eventually, my patients included "gassed" cases, convalescents from infectious diseases, patients with healing chest wounds, effort syndrome cases and a few other neurotics. About three-quarters of the cases were discharged to Class A duty and the rest were about evenly distributed, as Class B-2, Class C-2, and Class D by the Disability Board. The work proved to be successful. Some following up of the cases was begun, but was interrupted by the Armistice. Cards were printed and given to the soldiers discharged from these convalescent and "gassed" wards to be sent back after two weeks of duty. The replies indicated generally that the method of classification was satisfactory.

Tests. I shall now describe in detail the tests which we tried out before we decided finally on the ones that were the most practical. First we made a number of tests on several groups of young soldiers of average age, height and weight. One group consisted of five normal men; one of five convalescent "gassed" soldiers; one of five effort syndrome cases; and one of five psychoneurotic "shell-shock" soldiers. The tests were those of exercise and respiration, the latter following tests the British Aviation Service was using.

The respiratory tests were:

1. Breath-holding: length of time in seconds that the breath could be held.

2. Vital capacity: the amount in cubic centimeters of air that could be expelled from the chest after a maximum inspiration.

3. Expiratory force: as determined by the height in milligrams to which a mercury column, 4 mm. in diameter, could be blown.

4. Fatigue test: the length of time in seconds that the mercury column could be held by the respiration at 20 mm. height.

5. The amount of fluid (liquid paraffin) in cubic centimeters that could be blown over from one bottle into another. This combined the fatigue test factor and the vital capacity factor. This test was not one of the British Aviation Service.

The exercise tests as planned included:

1. Climbing two flights of steps in one minute of time, fifty steps in all, each one 16 cm. high.

The pulse-rate, respiratory-rate, systolic and diastolic blood-pressures and subjective sensations were noted before the exercise, immediately at the end of the exercise and two minutes and five minutes after the end of the exercise.

2. 100-meter walk and 100-meter run (dog trot) with the gas mask on.

The pulse-rate and general condition were recorded.

3. 5-kilometer march.

The pulse-rate, blood-pressure and general condition noted before and after.

We had hoped to carry out the 5-kilometer march test with the pack on, but the routine of work prevented.

TABLE I.—SUMMARY OF RESPIRATORY AND EXERCISE TESTS IN FOUR GROUPS OF SOLDIERS: NORMAL; CONVALESCENT "GASSED;" "EFFORT SYNDROME," AND PSYCHONEUROSIS WITH "SHELL SHOCK." AVERAGE FIGURES.

Group.	Respiratory tests.[1]					Exercise tests.															
						Stair climbing (50 steps, each 6½ inches high) in one minute.								Gas mask on.			5-kilometer march, 1 hour.				
						Pulse-rate.		Respiratory-rate.		Blood-pressure.							Pulse-rate.		Blood-pressure in mm. Hg.		
										Systolic.		Diastolic.							Systolic.		Diastolic.	
All soldiers.	Holding breath, time in seconds.	Vital capacity in c.c.	Mercury column; expiratory force; height in mm. to which mercury column can be blown.	Mercury column; fatigue test; time in seconds during which column kept up 20 mm.	Blow-bottle test; c.c. of paraffin oil blown from one bottle into another.	Increase (pulse-rates).	Decrease after 2 minutes' rest.	Increase (respiratory rates).	Decrease after 2 minutes' rest.	Increase in mm. Hg. (systolic pressure).	Decrease after 2 minutes' rest.	Change at once (diastolic pressure).	Change after 2 minutes' rest.	At rest.	After 100-meter walk.	After 100-meter run (dog trot).	Before.	After.	Before.	After.	Before.	After.
Normal, 5	73	4720	157	63	154	10	21	2	2	11	13	−8	+1	81	92	128	71	97	127	125	85	86
British Aviation figures (normal)	66	4000	119	52 Held at 40mm.																	
Effort syndrome, 5	41	3250	64	21	81	28	30	9	6	17	10	−5	+6	87	115	144						
Convalescents from gassing, 5	32	2840	71	14	80	17	18	5	4	13	13	+2	0	76	101	128	72	88	105	107	68	77
Neurotics ("shell shock"), 5	13	2240	23	6	31	19	17	17	5	18	17	+1	3+	Because of nervousness could not keep masks on								

[1] The figures are the averages of three trials in each respiratory test. This applies also to the four other tables.

TABLE II.—DETAILED TESTS IN FIVE NORMAL SOLDIERS.

Group.	Respiratory tests.					Exercise tests.															
						Stair climbing (50 steps, each 6½ inches high) in one minute.								Gas mask on.			5-kilometer march, 1 hour.				
						Pulse-rate.		Respiratory-rate.		Blood-pressure.							Pulse-rate.		Blood-pressure in mm. Hg.			
										Systolic.		Diastolic.							Systolic.		Diastolic.	
All soldiers.	Holding breath, time in seconds.	Vital capacity in c.c.	Mercury column; expiratory force; height in mm. to which mercury column can be blown.	Mercury column; fatigue test; time in seconds during which column kept at 20 mm.	Blow-bottle test: c.c. of paraffin oil blown from one bottle into another.	Increase (pulse-rates).	Decrease after 2 minutes' rest.	Increase (respiratory rate).	Decrease after 2 minutes' rest.	Increase in mm. Hg. (systolic pressure).	Decrease after 2 minutes' rest.	Change at once (diastolic pressure).	Change after 2 minutes' rest.	At rest.	After 100-meter walk.	After 100-meter run (dog trot).	Before.	After.	Before.	After.	Before.	After.
J. F. L. Age, 25 years; height, 5 ft. 8 in. (173 cm.); weight, 155 lbs. (70.5 kgm.)	85	5100	250	87	250	12 68–80	12 80–68	2 14–16	+2 16–18	10 120–130	12 130–118	0 90–90	−2 90–88	84	90	124	78	80	135	128	85	80
W. J. B. Age, 25 years; height, 5 ft. 10¼ in. (179 cm.); weight, 199 lbs. (90.5 kgm.)	60	3800	250	36	150	26 70–96	24 96–72	8 24–32	8 32–24	7 118–125	8 125–117	−8 90–82	+3 82–85	96	104	140	72	112	130	120	00	88
P. C. Age, 27 years; height, 6 ft. (183 cm.); weight, 195 lbs. (88.6 kgm.)	57	5300	110	42	100	22 76–98	30 98–68	4 16–20	4 20–16	25 125–150	20 150–130	−10 75–65	0 65–65	76	96	140	64	105	126	125	70	75
C. S. G. Age, 29 years; height, 5 ft. 11¼ in. (181 cm.); weight, 140 lbs. (67.7 kgm.)	00	5000	95	90	140	14 74–88	16 88–72	−4 24–20	+1 20–21	8 110–118	13 118–105	−12 92–80	0 80–80	74	80	114	70	84	120	118	87	90
J. O. M. Age, 30 years; height, 5 ft. 9 in. (175+ cm.); weight, 165 lbs. (75 kgm.)	76	4350	80	60	130	20 68–88	24 88–64	2 16–18	2 18–16	4 120–124	10 124–114	−10 90–80	+5 80–85	75	88	120	72	104	125	135	92	95

TABLE III.—DETAILED TESTS IN FIVE SOLDIERS WITH MILD "EFFORT SYNDROME."

Group.	Respiratory tests.					Exercise tests.																
						Stair climbing (50 steps, each 6½ inches high) in one minute.								Gas mask on.			5-kilometer march, 1 hour.					
						Pulse-rate.		Respiratory-rate.		Blood-pressure.							Pulse-rate.		Blood-pressure in mm. Hg.			
										Systolic.		Diastolic.							Systolic.		Diastolic.	
All soldiers.	Holding breath, time in seconds.	Vital capacity in c.c.	Mercury column; expiratory force: height in mm. to which mercury column can be blown.	Mercury column; fatigue test; time in seconds during which column kept at 20 mm.	Blow-bottle test; c.c. of paraffin oil blown from one bottle into another.	Increase (pulse-rate).	Decrease after 2 minutes' rest.	Increase (respiratory rate).	Decrease after 2 minutes' rest.	Increase in mm. Hg. (systolic pressure).	Decrease after 2 minutes' rest.	Change at once (diastolic pressure).	Change after 2 minutes' rest.	At rest.	After 100-meter walk.	After 100-meter run (dog trot).	Before.	After.	Before.	After.	Before.	After.
N. Heart and lungs normal	48	3400	65	17	37	14 86–100	10 100–84	18 22–40	16 40–24	20 100–120	5 120–115	−12 80–68	+4 68–72	116	122	184						
R. Heart and lungs normal	70	4700	70	43	57	20 72–92	32 92–60	4 20–24	0 24–24	16 93–114	14 114–100	−9 75–66	+12 66–78	72	100	120						
L. Heart and lungs normal	35	3450	130	10	60	44 72–116	32 116–84	8 16–24	2 24–22	34 126–160	14 160–146	0 82–82	+8 82–90	60	120	130						
McK. Heart and lungs normal	42	3350	100	35	160	24 88–112	28 112–84	10 22–3	10 2–22	14 116–13	16 0–114	−4 66–6	+6 2–68	78	112	156						
R. Heart and lungs normal: very neurotic	10	1350	40	0	8	40 80–120	40 0–80	3 15–18	2 16–16	2 136–13	0 8–138	0 72–7	0 2–72	108	120	129						
Average weight and height.																						

TABLE IV.—DETAILED TESTS IN FIVE SOLDIERS CONVALESCENT FROM "GASSING."

Group.	Respiratory tests.						Exercise tests.															
							Stair climbing (50 steps, each 6½ inches high) in one minute.									Gas mask on.			5-kilometer march, 1 hour.				
							Pulse-rate.		Respiratory-rate.		Blood-pressure								Pulse-rate.		Blood-pressure in mm. Hg.			
											Systolic.		Diastolic.								Systolic.		Diastolic.	
All soldiers.	Holding breath, time in seconds.	Vital capacity in c.c.	Mercury column; expiratory force; height in mm. to which mercury column can be blown.	Mercury column; fatigue test; time in seconds during which column kept at 20 mm.	Blow-bottle test; c.c. of paraffin oil blown from one bottle into another.		Increase (pulse-rates).	Decrease after 2 minutes' rest.	Increase (respiratory rates).	Decrease after 2 minutes' rest.	Increase in mm. Hg. (systolic pressure).	Decrease after 2 minutes' rest.	Change at once (diastolic pressure).	Change after 2 minutes' rest.	At rest.	After 100-meter walk.	After 100-meter run (dog trot).	Before.	After.	Before.	After.	Before.	After.
V. Mustard gas 2 weeks ago; dyspnea, weakness and dizziness; burn of neck; no cough; lungs clear	7	2000	50	4	20		12 86–0	8–86	6 36–4	2–36	10 104–11	1–100	−6 74–6	−10 8–58	72	130 Faint	Not tried	76 Fell	112 out	100 for	102 rest	72	78
W. N. Mustard gas 10 days ago; dyspnea, skin burns, conjunctivitis; lungs clear	19	2500	50	18	50		14 88–10	2–76	10 22–3	2–26	10 96–10	2 6–104	+8 60–6	+16 8–84	84	112	148	66 Fell	84 out	100 for	102 rest	64	68
T. M. B. Mustard gas 2 weeks ago; cough, hoarseness, burns of scalp; heart and lungs clear	23	2600	50	10	65		30 90–12	22 0–08	3 21–2	5 1–19	18 112–13	26 0–104	0 80–8	0 0–80	84	90	130	84	90	116	125	80	98
C. C. Phosgene gas 10 days ago; dyspnea and slight cough; heart and lungs clear	83	4000	200	25	180		18 58–7	22 6–54	0 20–2	1 0–19	9 103–11	7 2–105	−2 60–5	+2 8–60	56	72	104	52 Excellent	63 condition	104	104 no	60	70
J. E. H. Mustard and phosgene gases 2 wks. ago; cough, hoarseness, neck burns; heart and lungs clear	29	3100	50	11	40		10 84–9	14 4–80	5 19–2	5 1–19	20 90–11	16 0–94	+10 50–6	−8 0–52	82	100	130	84 Good	92 condition	107	102	62	70

TABLE V.—DETAILED TESTS IN FIVE SOLDIERS WITH THE "SHELL-SHOCK" TYPE OF PSYCHONEUROSIS.

Group.	Respiratory tests.					Exercise tests.															
						Stair climbing (50 steps, each 6¾ inches high) in one minute.								Gas mask on.			5-kilometer march, 1 hour.				
						Pulse-rate.		Respiratory-rate.	Blood-pressure.								Pulse-rate.		Blood-pressure in mm. Hg.		
									Systolic.		Dinstolic.								Systolic.		Dinstolic.
All soldiers.	Holding breath, time in seconds.	Vital capacity in c.c.	Mercury column; expiratory force; height in mm. to which mercury column can be blown.	Mercury column; fatigue test; time in seconds during which column kept at 20 mm.	Blow-bottle test; c.c. of paraffin oil blown from one bottle into another.	Increase (pulse-rates).	Decrease after 2 minutes' rest.	Increase (respiratory rates).	Increase in mm. Hg. (systolic pressure).	Decrease after 2 minutes' rest.	Change at once (diastolic pressure).	Change after 2 minutes' rest.	At rest.	After 100-meter walk.	After 100-meter run (dog trot).	Before.	After.	Before.	After.	Before.	After.
Hu. Shell shock 1 month ago; very shaky; heart and lungs normal	7	2450	30	0	15	0 92–92	2–88	30 22–52	0 52–52	15 150–165	15 165–150	+25 85–110	−10 110–100	Not	attempted	because of	condition	very	nervous		
A. High explosive concussion 1 month ago; slightly tremulous; heart and lungs normal	19 By great urging	1200	18	5	35	28 70–101	16 84–88	19 21–40	12 40–28	8 110–118	8 118–110	0 75–75	0 75–75		"		"		"		
Ho. Shell shock 2 weeks ago; deaf, dumb and very tremulous; heart and lungs normal	9	1400	35	12	25	22 90–112	20 92–92	12 20–32	8 32–24	22 128–150	20 150–130	−4 78–74	+6 84–80		"		"		"		
Re. High explosive concussion 3 weeks ago; slightly tremulous; heart and lungs normal	13	4300	40	10	30	−4 116–112	16 96–96	2 22–24	2 24–22	36 120–156	32 156–124	−13 98–85	+13 85–98		"		"		"		
Co. High explosive concussion 10 weeks ago; nervous and dyspneic; heart and lungs normal	18	1850	34	5	10	50 70–120	28 92–92	20 20–40	4 40–36	10 125–135	11 135–124	−5 90–85	+9 85–91		"		"		"		

Discussion of Results. From the tables it is obvious that the cases most strikingly limited in capacity in nearly all of the tests were the "shell-shock" cases of psychoneurotics. Incidentally the convalescents from acute infectious disease, as a rule, did well in the exercises or games tried and went back to duty more quickly than any of the others, provided there was no pronounced neurotic element as an additional factor. It always proved of extreme importance to look for nervousness in all cases convalescent from any condition. Such nervous cases, although apparently recovered, generally responded poorly to the tests, and really were not fit. Such people were often bright, capable of careful mental work, but not for the strenuous physical war game. Race seemed often a factor.

All these tests appeared to be much more tests of the fitness of the nervous system than of the heart and lungs *per se*. To stimulate convalescence and to obtain an excellent test for malingering (which was usually of the unconscious type and not infrequently found), base-ball games were held about twice a week, the wards playing against each other, and as many substitutes used in the game as possible. The medical officer kept score on the side lines, thus closely following individual players. Some of the games were exceedingly close and interesting, and usually the men in the midst of the play forgot their symptoms. Some of them showed themselves easily fitted who had been complaining previously a good deal, while others were obviously exhausted by dash to the first or second base, for example. Games such as these, followed closely, prove an excellent stimulus as well as a test for physical fitness.

The test which we finally employed as the best, taking into consideration exertion, excitement and the need of economy of time and effort on the part of the medical officer, was the 100-meter run with the gas mask on. The run provided the exertion and the gas mask the mental spur. Bad general appearance, breathlessness, pain, faintness, cough, extreme tachycardia and exhaustion were the conditions looked for at the finish of the run and helped decide on the fitness of the individual. This test was used on about 2000 soldiers.

There is one further observation that I should like to make. Many of the soldiers, I should hazard probably one-third, sent down to our Base Hospital as gassed, showed only nervousness when they reached the hospital. It is quite likely that that was all that was troubling many of the A. E. F. who said that they had been "gassed."

Summary. 1. Various tests, respiratory and exercise, are described which were applied in U. S. Base Hospital No. 6, A. E. F., to small groups of normal soldiers, convalescent "gassed" soldiers and to neurotics of the "effort syndrome" and "shell-shock" types.

2. The 100-meter run with the gas mask on was the test finally chosen as the most practical for use at U. S. Base Hospital No. 6 in determining the fitness of the soldier to return to combat duty.

3. All the tests proved to be tests rather of stability of the nervous system than of cardiac and pulmonary condition *per se:* the more nervous a man the poorer his reaction.

4. One of the most important applications to civilian medicine of the lessons from these tests is with respect to the vital capacity, which proved to be rather a test, as mentioned above, of nervous stability than of the condition of the cardiovascular or respiratory systems *per se,* in the groups under discussion.

LIFE-CYCLES OF THE BACTERIA AND THEIR POSSIBLE RELATION TO PATHOLOGY.

By Ralph R. Mellon, M.Sc., M.D., Dr.P.H.,
DIRECTOR OF LABORATORIES, HAHNEMANN HOSPITAL, ROCHESTER, N. Y.

Very early in the history of bacteriology the belief prevailed that the various morphological units were quite interchangeable, *e. g.,* rod forms easily developed into coccus forms, and *vice versa.* As bacteriological methods were improved it became evident that in the majority of instances these changes were apparent only —that when a bacterial species or type was once isolated and subsequent contamination guarded against the induction in it of cultural and biological changes was no simple matter. In other words a pure culture, under the artificial conditions of the laboratory, would "breed true" to the characteristics that had fixed its specific ranking.

As a result the theory of fixity or immutability of bacterial types has gradually supplanted the primitive view of an unrestrained plasticity of bacterial protoplasm. For the designation of the curious but fluctuating changes in form displayed by pure cultures when subjected to variations of environment we have the term polymorphism or pleomorphism, while the term involution is applied to the bizarre forms often present in old cultures. The latter were regarded as degenerated forms, usually incapable of reproduction, and as such the counterpart of a deterioration in the nutritive qualities of the medium.

For several decades these fundamental ideas have completely dominated our conceptions of bacteria in relation to disease. The simple processes of transverse fission and spore formation have been thought to embrace practically the entire truth concerning the life-history of bacteria. Despite these facts, there has always existed a residuum of workers, who, unable to doubt experimental evidence, have not yet been entirely convinced that the story was so simple—

ho have felt that, bound up in some way with these curious morphological changes, were fundamental biological principles, which